PYRAMID Technical Standard Version 1.0

Version Description Document Issue 1.0

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CHANGE HISTORY

Date	Issue	Description of Changes
February 2025	1.0	First Issue.

List of Effective Pages

41 pages in total

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REFERENCES

PYRAMID Document References:

Reference	Author/Organisation, Date, Title, Document Number & Issue
[1]	Ministry of Defence, February 2025, PYRAMID Technical Standard, PYD/TechStan/V1.0.
[2]	Ministry of Defence, February 2025, PYRAMID Technical Standard Guidance, PYD/TechStanGuide/V1.0.
[3]	Ministry of Defence, February 2025, PYRAMID Technical Standard Guidance Version Description Document, PYD/TechStanGuide/V1.0/VDD/Issue 1.0.
[4]	Ministry of Defence, February 2025. PYRAMID Model, PYD/TechStanModel/V1.0.
[5]	Ministry of Defence, September 2023, PYRAMID Exploiter's Pack, RCO_FUT_23_004, Version 4.1.

Other References

Reference	Author/Organisation, Date, Title, Document Number & Issue
[6]	Object Management Group, June 2015, XML Metadata Interchange (XMI) Specification, Version 2.5.1.

1 Introduction

1.1 PYRAMID and PYRAMID Reference Architecture

Military aircraft effectiveness is critically dependent on software, especially mission systems software, and fundamental to this effectiveness is the ability to provide new capability where and when it is required. Further to this, effective partnering, capability exchange, and interoperability between allies is essential for operational success.

Traditional software design has been such that relatively small changes can have wide reaching consequences across the aircraft, and the scope for reuse across air platforms (including support systems) and programmes has been limited. This problem has become even more significant with the rapid growth in the complexity of military air system software to meet capability needs. In response, the PYRAMID programme was established to enable technology advantage though systematic software reuse and rapid adaptability.

Modularity and open architectures have been identified as key enablers, but their consistent application across air platforms, and ensuring compatibility with other standards, is essential if the benefits are to be fully realised. In response, a number of open architecture standards have been developed to address areas such as hardware design, data architectures, and software architectures including middleware; but a gap was identified for application software.

The PYRAMID Technical Standard, Ref. [1], has been developed to provide a consistent approach to modularising air system application software though the PYRAMID Reference Architecture (PRA), whilst ensuring that fundamental requirements, including airworthiness certification and security accreditation, can also be achieved.

An accompanying document, the PYRAMID Technical Standard Guidance, Ref. [2], has also been produced to provide guidance and supporting information to aid understanding and application of the PYRAMID Technical Standard, enabling the development of PYRAMID compliant systems.

1.2 PYRAMID Development

The PYRAMID Exploiter's Pack, Ref. [5], has undergone a significant restructuring due to the transformation required for PYRAMID to become a standard. Most notably, the PYRAMID Exploiters Pack has been re-expressed as two documents:

- The PYRAMID Technical Standard, Ref. [1], which contains all the normative content required to be compliant with the PRA.
- The PYRAMID Technical Standard Guidance, Ref. [2], which contains the majority of the informative content, providing guidance and supporting information to aid understanding and application of the PYRAMID Technical Standard, enabling the development of PYRAMID compliant systems.

The PYRAMID Reference Architecture (PRA) has continued to mature during the above transformation of the PYRAMID documentation and has now reached Version 6. The PRA has been redefined to no longer include the PYRAMID Concepts (formerly policies, for more information see Ref. [3]), PYRAMID Interaction Views, and Use Cases. This is due to the fact that these three artefacts are not considered to be normative instruction for maintaining compliance with the PRA. Table 1 shows the development of the PRA alongside the associated documentation.

PYRAMID Documentation Version	PRA Version
PYRAMID Exploiter's Pack Version 4.1	PYRAMID Reference Architecture Version 4
PYRAMID Exploiter's Pack Version 5* (unreleased)	PYRAMID Reference Architecture Version 5* (unreleased)
PYRAMID Technical Standard V1.0 and PYRAMID Technical Standard Guidance V1.0	PYRAMID Reference Architecture Version 6

Table 1: PRA Development

**PYRAMID Exploiter's Pack v5, Ref. [5], was not released, since it was used to develop a solid foundation for the PYRAMID Technical Standard, including incorporating exploiter feedback. Neither PRA v5 nor PYRAMID Exploiter's Pack v5 are available for distribution.*

1.3 Scope

As the PYRAMID Technical Standard and PYRAMID Technical Standard Guidance supersede the PYRAMID Exploiter's Pack, this document details changes impacting the former since the last available release of the PYRAMID Exploiter's Pack (v4.1), Ref. [5].

This document describes the changes to the Technical Standard content and Version 6 of the PYRAMID Reference Architecture, Ref. [4], with a particular focus on the PYRAMID compliance rules, PRA component composition, and PRA component set, as well as an overview on the restructure of the PYRAMID documentation. While these changes are captured within this document, it is recommended that an exploiter reads the PYRAMID Technical Standard in full up to and including the component composition for a full appreciation of the content.

For changes made between PYRAMID Exploiter's Pack v4.1 and the corresponding content in the PYRAMID Technical Standard Guidance please refer to the PYRAMID Technical Standard Guidance Version Description Document, Ref. [3].

1.4 Structure

This Version Description Document is structured as follows:

Section 1: Introduction – An introduction to the document and its content, scope, and structure.

Section 2: PYRAMID Technical Standard V1.0 Release Notes – This section explains the restructuring of the PYRAMID Exploiter's Pack into the PYRAMID Technical Standard and PYRAMID Technical Standard Guidance and gives a summary on what has changed with a particular focus on PYRAMID compliance rules, PRA component composition, and PRA component set.

Appendix A: Impacted Components – This section includes a list of which components are impacted and by what degree.

Appendix B: Technical Standard Detailed Changes – The specific changes made between PYRAMID Exploiter's Pack v4.1 and the corresponding content in the PYRAMID Technical Standard. The focus being on the PYRAMID compliance rules, PRA component composition, and PRA component set.

Appendix C: PYRAMID Model Installation Instructions – Instructions for installing the PYRAMID model in various formats, and the limitations for the different model formats.

2 PYRAMID Technical Standard V1.0 Release Notes

This section summarises the changes that have taken place between PYRAMID Exploiter's Pack v4.1, Ref. [5], and PYRAMID Technical Standard V1.0, Ref. [1]. The primary change is that the PYRAMID Exploiter's Pack has been restructured into the PYRAMID Technical Standard and an accompanying guidance document. PYRAMID is now a Technical Standard and has been modified as such.

2.1 Document Structure Changes

In order to develop the PRA into a standard, it became essential to separate the normative content from the informative content, so that exploiters can clearly distinguish what is required to be compliant from supporting information and guidance. Figure 1 summarises how the PYRAMID Exploiter's Pack content has been redistributed to form the PYRAMID Technical Standard, Ref. [1], and PYRAMID Technical Standard Guidance Ref. [2]. With the following notable exceptions, the PYRAMID Exploiter's Pack has been redistributed between these two documents:

- Reader Guidance has changed significantly, and the previous content now forms most of the content in the main body of the PYRAMID Technical Standard Guidance, Ref. [2].
- Content describing the key user requirements (KURs) has not been included.

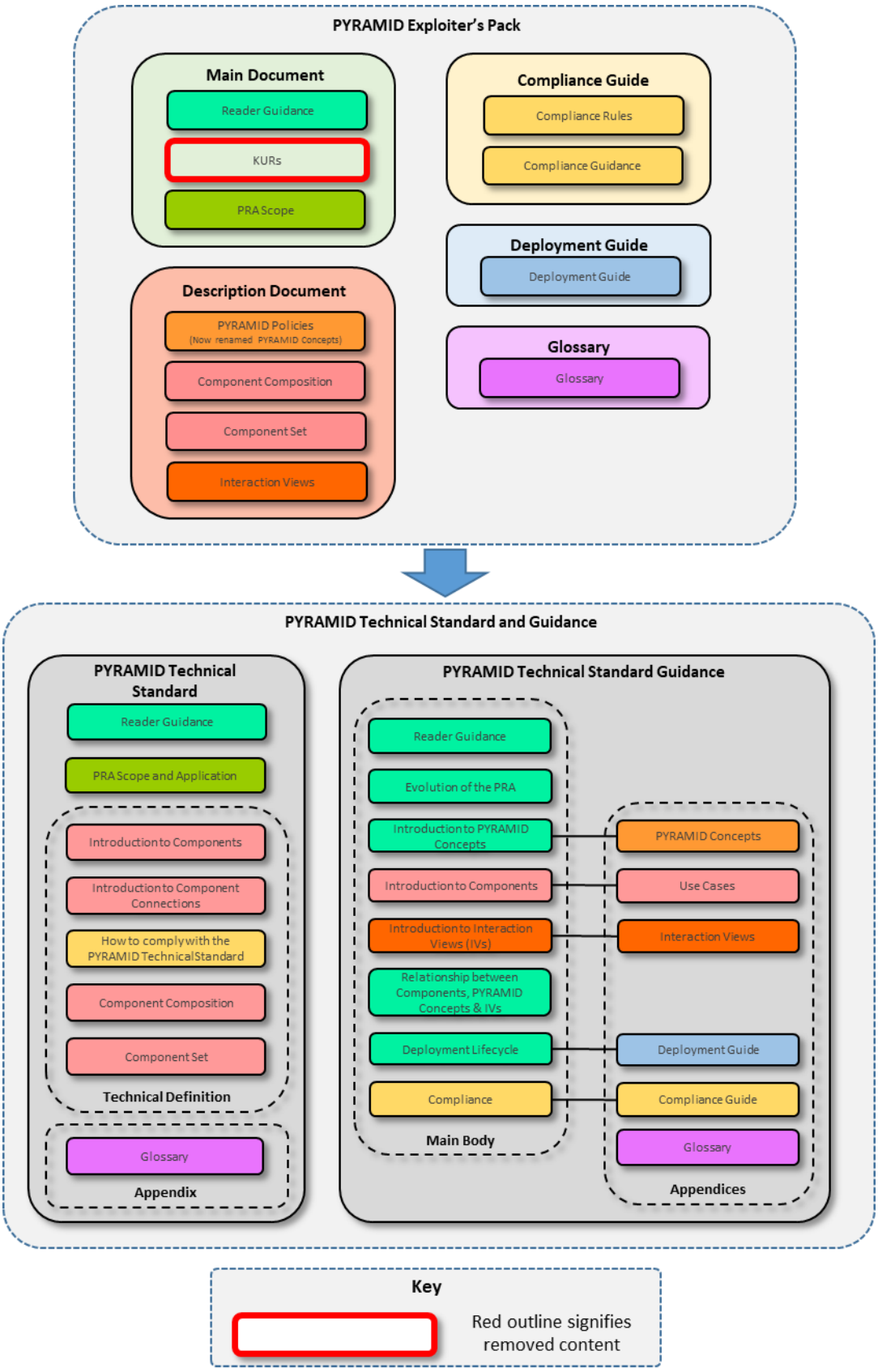

Figure 1: PYRAMID Restructure

2.2 Technical Standard Change Summary

As the PYRAMID Exploiter's Pack has now transitioned into the PYRAMID Technical Standard and accompanying guidance document, all normative content is captured within the PYRAMID Technical Standard while the majority of informative content is captured within the PYRAMID Technical Standard Guidance. Due to the volume of change, it is recommended that exploiters read through the PYRAMID Technical Standard, at least up to and including the component composition, to ensure that changes to normative content are understood.

This section will provide a brief overview of changes to the PRA and the compliance rules that affect the PYRAMID Technical Standard, Ref. [1]. This list is intended to give the reader a general idea of what has changed as well as prompt them to reread sections relevant to them as necessary.

2.2.1 Compliance Rule Changes

The PYRAMID Exploiter's Pack, Ref. [5], included a Compliance Guide that defined the PYRAMID compliance rules and provided supporting information to aid exploiters seeking to understand and demonstrate compliance.

The rules for achieving PYRAMID compliance are now defined within the PYRAMID Technical Standard, Ref. [1], with supporting guidance material provided in the PYRAMID Technical Standard Guidance, Ref. [2]. Both the compliance rules and the supporting guidance material have been revised. Changes to the supporting guidance are described in the PYRAMID Technical Standard Guidance Version Description Document, Ref. [3]. Changes to the compliance rules are described in this document.

Within the PYRAMID Technical Standard, the presentation structure of the compliance rules has also been modified slightly. The PYRAMID Technical Standard defines compliance rules for individual components, component connections and deployments. The goal of the component and component connection compliance rules remains unchanged, but the rules are expressed differently. The rule for component extensions has been deleted. Appendix B provides the PYRAMID Exploiters Pack v4.1 rules and PYRAMID Technical Standard V1.0 rules side by side for comparison and highlights the specific differences.

The revised component compliance rule aims to clarify what is required for a PYRAMID component to be consistent with the defined subject matter of the PRA component. However, the goal of component compliance remains unchanged, and it is anticipated that PYRAMID components assessed as compliant against the rules in v4.1 may be assessed as compliant against the rules within PYRAMID Technical Standard V1.0, where the scope of the PRA component remains unchanged. A PYRAMID component assessed as compliant at v4.1 may be assessed as non-compliant against the PYRAMID Technical Standard V1.0, as a result of changes to the scope of a PRA component, as detailed in section B.1. The PYRAMID Technical Standard Guidance, Ref. [2] should be consulted for comprehensive guidance in respect of the revised compliance rules.

2.2.2 Component Composition Changes

Major Themes	Impact on the Standard Documentation
Introduction of generic responsibilities and services.	The component composition now includes generic responsibilities and services, which are applicable to most or all PRA components – such as services to support data logging. The generic nature of these responsibilities and services means that they cannot be meaningfully specialised within any specific PRA component and so can be used in the development of any PYRAMID component.
PYRAMID Concept normative content formalised in the Component Composition	The PYRAMID Concepts have been assessed for any potential normative content implied by them. Where the concepts implied normative content that was not explicitly included within the PRA component set or the component composition, the content has been added to the relevant PRA components or the component composition. Most of these additions apply solely to the component composition, since they tend to be concepts that apply to all components, and as such tend to be included as generic responsibilities and services (as described above). Note that, the relevant content in the PYRAMID Concepts now reference the normative PRA content, making the PYRAMID Concepts entirely informative.
Additional detail and explanation	The component composition services, service activities, and service dependency diagrams have been enhanced to show the interactions between different services and activities within services more clearly.

Table 2: Component Composition Change Summary

In each of the above cases, the impact on an exploiter is none. The changes provide additional detail and expand the content, or explanation of the content, that can be applied to most PYRAMID components. Exploiters are not obliged to implement this new content, although exploiters may choose to align their PYRAMID components to the new content to increase capability or for greater interoperability opportunities.

2.2.3 PRA Component Set Changes

Major Themes	Impact on the Standard Documentation	Impact on an Exploiter
Revised approach to resource management and conflict resolution	The approach to resource management has been modified. As part of this change in approach the following changes were made to the PRA, Ref. [4]: • The Resource Brokerage component has been removed from the PRA. • The Spectrum component is reclassified a resource component and has been modified as such. • Resource allocation and conflict identification is now undertaken by resource components; these components have been changed accordingly. • A new component called Conflict Resolution has been added to the PRA. This component provides a more generalised brokering and arbitration function applicable to both resource and non-resource conflicts. The component composition has had services incorporated to support conflict resolution.	Resource Brokerage PYRAMID components will not be compliant with the latest version of the PRA, see Ref. [1], or compatible with other compliant PYRAMID components developed to the latest version. Exploiters that have previously developed resource components may need to develop these components further to incorporate resource allocation and conflict identification capability. If exploiters have already developed a Spectrum component, there is a risk that it may not be compliant to the revised PRA component definition. Deployments with resource management capability will require modification to align to the new resource management component interaction pattern.
Removed the Path Demands component	The Path Demands component has been removed from the PRA and its subject matter is now distributed across the following components, resulting in modification to these components: • Routes • Vehicle Guidance • Vehicle Performance • Conflict Resolution (a new PRA component)	Path Demands PYRAMID components will not be compliant with the latest version of the PRA and may not be compatible with other compliant PYRAMID components developed to the latest version. A new Conflict Resolution component may be required, and existing developments of the following components may need updating to expand their capability: • Routes • Vehicle Guidance • Vehicle Performance

Major Themes	Impact on the Standard Documentation	Impact on an Exploiter
Applied maintenance fixes to PRA Components	Most components have undergone some level of change during the development of the PRA between v4 and v6, Ref [4]. See sections A.1 and B.3 for further detail.	See Section B.3.

Table 3: PRA Component Set Change Summary

Appendix A: Impacted Components

Table 4: Level of Change within PRA Component Set displays the highest level of change undergone since PRA V4. The categories are as follows:

- **Scope:** A change to the defined subject matter scope as expressed by the component's responsibilities. For example, the addition, removal or substantive revision of responsibilities. This may include changes to entity definitions where this results in a change in the scope of responsibilities that reference those entities (even if the responsibility wording itself is unchanged). As a result of any such change to the responsibilities, corresponding changes may exist in other parts of the component definition. For example, role, subject matter definition, and services.
- **Technical - Major:** Significant changes to the component definition, but where the defined subject matter scope is unchanged. Such changes include the addition, removal, or substantive revision of services or a substantive change to the pattern of use or subject matter semantics.
- **Technical - Minor:** Less significant changes to the component definition and where the defined subject matter scope is unchanged. Such changes may include changes to the designated control architecture layer, examples of use, design rationale and minor changes to the pattern of use or subject matter semantics. This can also include minor bug fixes to technical content.
- **Technical - Clarification:** Change that should only affect how the technical content is read or understood by an exploiter.
- **Editorial:** These changes are not significant and do not affect the technical content of PYRAMID Technical Standard. They are solely textual for the improvement of readability, or inconsequential bug fixes. For example, if a diagram had its presentation altered, it is inconsequential therefore editorial.

The PYRAMID Technical Standard defines the component responsibilities as the normative element of the component definition for the purpose of component compliance assessment. Therefore, PRA component changes that are categorised as scope changes in Table 4: Level of Change within PRA Component Set may impact the compliance of a PYRAMID component developed to earlier versions of the PRA if reassessed against the latest version of the PRA.

PRA component changes in other categories should not impact compliance. However, where PYRAMID components have been developed in accordance with the previous version of the PRA and have closely aligned with some of the non-prescriptive aspects of the component definition, this alignment may be impacted; for example, where a PYRAMID component has developed services closely aligned to those defined in the PRA component definition and these services have been revised.

It is recommended that all relevant technical changes are reviewed, including those categorised as clarifications, since these may impact how the component definition is interpreted even though the scope of the component has not strictly been modified.

Additional Notes: The Tactics Tasks extensions are no longer considered part of the PRA, and these are presented in the PYRAMID Technical Standard Guidance, Ref. [2]. Therefore, their changes are in the guidance Version Description Document, Ref. [3].

A.1 Level of Change

Component	Change at PRA V6
Anomaly Detection	Technical - Minor
Asset Transitions	Technical - Major
Authorisation	Scope*
Collision Avoidance	Technical - Minor
Collision Prediction	Editorial
Communication Links	Editorial
Communicator	Scope
Conflict Resolution	New to PRA
Countermeasures	Technical - Major
Cryptographic Materials	Editorial
Cryptographic Methods	Technical - Minor
Cyber Defence	Editorial
Data Distribution	Technical - Minor
Data Fusion	Technical - Major
Destructive Effects	Technical - Clarification
Effectors	Scope
Environment Infrastructure	Editorial
Environment Integration	Technical - Major
Environmental Conditioning	Scope*
Flights	Technical - Minor
Fluids	Scope
Formations	Editorial
Geography	Technical - Clarification
Health Assessment	Technical - Minor
HMI Dialogue	Technical - Minor
Human Interaction	Technical - Clarification
Information Brokerage	Editorial
Information Presentation	Editorial
Interlocks	Technical - Minor
Inventory	Editorial
Jettison	Technical - Minor
Lights	Editorial
Location and Orientation	Technical - Major
Mass and Balance	Scope*
Mechanical Positioning	Scope
Navigation Sensing	Technical - Minor
Network Routes	Scope
Networks	Technical - Minor
Objectives	Technical - Major
Observability	Editorial
Operational Rules and Limits	Technical - Major
Path Demands	Removed from PRA
Pointing	Technical - Clarification
Power	Scope
Propulsion	Scope
Reference Times	Technical - Minor

Component	Change at PRA V6
Release Aiming	Technical - Major
Release Effecting	Scope
Resource Brokerage	Removed from PRA
Routes	Scope
Semantic Translation	Technical - Major
Sensing	Technical - Major
Sensor Data Interpretation	Technical - Major
Sensor Products	Technical - Major
Sensors	Scope
Signature	Editorial
Spatial Correction	Editorial
Spectrum	Scope
Storage	Editorial
Stores Release	Technical - Minor
Susceptibility	Editorial
Tactical Objects	Technical - Minor
Target Engagement	Technical - Major
Tasks	Scope
Test	Technical - Major
Threats	Technical - Minor
Trajectory Prediction	Editorial
Undercarriage	Technical - Minor
User Accounts	Editorial
User Roles	Technical - Major
Vehicle External Environment	Technical - Minor
Vehicle Guidance	Scope
Vehicle Performance	Scope
Vehicle Stability and Control	Technical - Major
Weather	Technical - Minor

Table 4: Level of Change within PRA Component Set

*These components have been declared as having scope change due to the addition/change of responsibilities; however, their subject matter has not changed. Responsibilities were not the measure of compliance, or the predominant measure of a components subject matter, at PRA v4.

Appendix B: Technical Standard Detailed Changes

B.1 Compliance Rules

The following figures directly compare the compliance rules defined for the PYRAMID Exploiter's Pack V4.1, Ref. [5], with the rules defined in the PYRAMID Technical Standard V1.0, Ref. [1]. While the nature of the changes are summarised, the PYRAMID Technical Standard Guidance, Ref. [2] should be consulted for comprehensive guidance in respect of the revised compliance rules.

B.1.1 Component Compliance

PYRAMID Exploiter's Pack V4.1	PYRAMID Technical Standard V1.0
"The implemented component's provided services are within the subject matter of the PRA component."	*"A PYRAMID component's content shall be consistent with the responsibilities of the target PRA component."*

Figure 2: Component Compliance Rule Comparison

The goal of the component compliance rule remains unchanged, and this is that PYRAMID components are consistent with the PRA defined component subject matter. However, the PYRAMID Technical Standard defines the PRA component responsibilities as the normative aspect of the component definition for the purpose of component compliance assessment. To achieve compliance, the functionality of a PYRAMID component is required to be consistent with the scope of the responsibilities of the target PRA component.

B.1.2 Component Connection Compliance

PYRAMID Exploiter's Pack V4.1	PYRAMID Technical Standard V1.0
"All of the component connections within the deployment do not contain subject matter defined within the scope of a PRA component."	"A bridge shall not fulfil a responsibility of a PRA component."

Figure 3: Component Connection Compliance Rule Comparison

While previously presented as a deployment compliance rule, the goal of this rule remains unchanged, and this is that PYRAMID component connections do not inappropriately fulfil (or partially fulfil) the responsibilities defined for a PRA component. However, the PYRAMID Technical Standard defines the PRA component responsibilities as the normative aspect of the component definition for the purpose of component compliance assessment. To achieve compliance, a deployment should seek to avoid implementing the functionality of a PRA component within a bridge.

B.1.3 Deployment Compliance

PYRAMID Exploiter's Pack V4.1	PYRAMID Technical Standard V1.0
"All of the components within a deployment are compliant, as determined by the PYRAMID component compliance rule."	"All the components within the PYRAMID deployment scope shall satisfy the rules for PYRAMID component compliance. All the component connections within the PYRAMID deployment scope shall satisfy the rules for PYRAMID component connection compliance."

Figure 4: Deployment Compliance Rule Comparison

Within the PYRAMID Technical Standard V1.0, deployment compliance is defined as the achievement of component compliance for all components within the PYRAMID deployment scope and a compliant means of connecting those components.

B.1.4 Extension Compliance

PYRAMID Exploiter's Pack V4.1	PYRAMID Technical Standard V1.0
"Where extension components exist within the deployment, only the parent components have access to the provided services of their extension component(s). An extension component can consume services from elsewhere as long as they are compatible with the parent's services."	No corresponding rule.

Figure 5: Extension Compliance Rule Comparison

Within the PYRAMID Technical Standard V1.0, there are no compliance rules that apply specifically to component extensions other than the component compliance rule, which is applicable to all component variants including extensions.

Within the PYRAMID Technical Standard Guidance, criteria are provided that are used to define an extension. The criteria are equivalent to the rule stated in PYRAMID Exploiter's Pack V4.1. Where a component variant is developed that meets the criteria, the component can be declared as a component extension, but this is not deemed a question of PYRAMID compliance.

B.2 Component Composition

There have been significant changes to the component composition and the associated component composition overview. It is, therefore, recommended that these are reread in full.

The component composition now contains responsibilities and services that, rather than being specialised within individual component definitions, are provided in generic format. These generic responsibilities and services supplement those defined for individual components, where they are identified as being applicable. This means that they are not included on individual PRA component definitions, since they are inherently

generic in nature, but they can be used in accordance with their applicability defined in the component composition when developing any PYRAMID component.

The relevant elements are the responsibilities and services or specific parts of a services, such as service activities and service attributes. The component composition clearly states where these elements are not included in the individual PRA component definitions.

B.2.1 Use Cases

The use cases are no longer part of the component composition. They are now contained within the PYRAMID Technical Standard Guidance, Ref. [2], and so any changes to them are detailed in the PYRAMID Technical Standard Guidance Version Description Document, Ref. [3].

B.2.2 Subject Matter Semantics

The entity names and descriptions have been updated, and additional entities have been added, to more closely align to the component composition services and responsibilities.

B.2.3 Responsibilities

The following responsibilities have been updated:

- capture_requirements
- determine_solution

The following responsibilities have been added:

- identify_conflict
- determine_refinement_goal
- determine_authorisation_dependencies
- address_capability_issue
- determine_retention_requirements
- manage_data_retention_and_storage
- coordinate_retention_activities
- determine_storage_requirements
- data_validation
- capture_autonomy_remit

B.2.4 Services

All of the component composition services have been updated to provide additional detail or clarity.

However, the following services have been updated in a more significant way:

- The Capability service now caters for addressing capability shortfalls.
- Additional activities have been added to the following services: Requirement, Constraint, and Capability.
- A refinement_goal attribute has been added to the following services in support of the conflict resolution pattern: Requirement, Solution_Dependency, and Constraint.
- The Achievement interfaces, on the Requirement and Solution_Dependency services, are modelled so they now inherit attributes from a Generic_Achievement interface, which now also includes an achievability attribute.
- The breach attribute description, on the Constraint interface, has been clarified.

The following services have been added:

- Retention_Requirement
- Dependency_Refinement
- Retention_Coordination_Dependency
- Storage_Dependency
- Constraint_Dependency
- Authorisation_Dependency
- Broker_Conflict

The component composition service dependency diagram has been replaced with a service dependency diagram for each of the major provided services. This allows greater detail to be shown without making the diagrams too cluttered. This is supported by the additional activities or improved activity descriptions for various component composition services.

B.3 Component Changes

Only components that have undergone change relevant to an exploiter are included within this section. All components have undergone some degree of editorial change and these changes are not included here. Therefore, components categorised as ‘editorial’ in Section A.1 are not included. Despite ‘Technical – Clarification’ changes being editorial in nature, they have an effect on an exploiter’s understanding of the content so are included. Despite technical content not changing, clarifications may alter how the content is perceived and are important to capture within this section. The terms ‘revised’, for technical changes, and ‘clarified’, for clarifications, are used to make these changes clear.

Knock on effects are also omitted for brevity. For example, if a service has been added, both the Service Summary and Service Dependency diagrams can be assumed to have been updated if necessary and only changes specifically to the Summary and Dependency diagrams are included. Similarly for Entities and the Subject Matter Semantics diagram.

Note: All resource components have changed in scope, due to their subject matter now including resource allocation, which is a necessary function for resource components to be able to satisfy the demands placed on them, in order to satisfy their existing responsibilities. In most cases this change is implicit, due to the removal of the Resource Brokerage component, i.e., resource allocation is no longer excluded from resource components due to it being the subject matter of another PRA component.

Component	Section	Sub-Section	Change Detail
Anomaly Detection	Role	NA	Clarified
	Overview	Standard Pattern of Use	Revised
		Examples of Use	Revised
	Subject Matter Semantics	Subject Matter Definition	Revised
		Entities	Revised: • Type_of_State • Anomaly • Actual_State • Expected_State
	Design Rationale	Design Considerations	Clarified
	Services	NA	Minor edits
Asset Transitions	Overview	Standard Pattern of Use	Clarified
		Examples of Use	Revised and new examples
		Service Summary	Diagram revised Asset_State_Information_Capability interface added State_Constraint interface changed to Transition_Constraint
	Responsibilities	NA	Renamed and clarified: • capture_state_constraints to capture_transition_constraints • determine_quality_of_transition_execution to determine_actual_quality_of_transition_deliverables • determine_quality_of_transition_solution to determine_predicted_quality_of_transition_solution Clarified: • identify_transition_solution_progress • predict_capability_progression
	Subject Matter Semantics	Entities	Added: • Transition_Constraint • Transition_Capability • Transition_Step • Possible_Transition • Available_Transition Removed: • Legal_Transition • Asset_Health • State_Constraint
	Design Rationale	Design Considerations	Extensions added and exploiter considerations clarified
	Services	NA	Revised: • Constraint • Capability Evidence

Component	Section	Sub-Section	Change Detail
Authorisation	Responsibilities	NA	Removed: • identify_pre-conditions Added: • determine_solution_dependencies
	Subject Matter Semantics	Entities	Added: • Context
	Services	NA	Added: • Contextual_Information Renamed and revised: • Authorisation Dependency to Authorisation_Solution_Dependency • Constraint
Collision Avoidance	Design Rationale	Design Considerations	Clarified and new exploiter consideration
	Services	NA	Revised: • Capability_Evidence
Communicator	Subject Matter Semantics	Entities	Added: • Dependency
	Services	NA	Added: • Communicator_Resourcing Revised: • Capability Evidence
Conflict Resolution	**New to the PRA**		
Countermeasures	Overview	Standard Pattern of Use	Clarified.
	Services	NA	Removed: • Deployable_Asset_Package_Creation • Effect • Formation • Deployable_Asset_Use • Threat_Level Added: • Threat_Information • Countermeasure_Action Revised: • Capability_Evidence • Environment_Information • Spectrum_Use • Vehicle Condition • Vehicle_Observability
Cryptographic Materials	Overview	Service Summary	Security_Group interface added

Component	Section	Sub-Section	Change Detail
Data Distribution	Overview	Control Architecture	Changed to 'service' component
		Standard Pattern of Use	Clarified
		Examples of Use	Revised
	Subject Matter Semantics	Subject Matter Definition	Clarified with example
		Exclusions	Clarified
		Semantics Diagram	Clarified
		Entities	Clarified: • Formatting_Rule • Delivery_Item
	Design Rationale	Assumptions	Revised
		Safety	Revised IDAL changed to DAL B
	Services	NA	Revised: • Capability_Evidence Clarified: • Delivery_Dependency • Distribution
Data Fusion	Services	NA	Removed: • Supporting_Information Added: • Environmental_Data • Vehicle_Data • Object_Data Revised: • Capability_Evidence
Destructive Effects	Subject Matter Semantics	Entities	Clarified: • Precondition
	Services	NA	Clarified: • Destructive_Effect_Settings
Effectors	Role	NA	Clarified
	Overview	Standard Pattern of Use	Clarified
		Examples of Use	Revised
	Subject Matter Semantics	Semantics Diagram	Clarified
		Entities	Revised: • Effect Clarified: • Requirement • Effector_Solution • Feedback • Effector_Function
	Design Rationale	Design Considerations	Exploitation Considerations clarified
	Services	NA	Revised: • Effector_Resourcing • Feedback_Information

Component	Section	Sub-Section	Change Detail
Environment Integration	Overview	Examples of Use	Example added
	Subject Matter Semantics	Exclusions	Exclusions added
	Design Rationale	Assumptions	All assumptions deleted
		Design Considerations	Exploitation Considerations clarified
	Services	NA	Removed: • Supporting_Information Added: • Environmental_Information • Asset_Information • Vehicle_Information Revised: • Capability_Evidence
Environmental Conditioning	Overview	Standard Pattern of Use	Clarified and updated to use revised entities
	Responsibilities	NA	Revised to use revised entities Removed: • identify_preconditions
	Subject Matter Semantics	Semantics Diagram	Revised
		Entities	Removed: • Conditioning_Action • Sequence • Conditioning_Action_Type • Precondition • Conditioning_Medium • Effector_Capability • Solution Added: • Conditioning_Mechanism • Conditioning_Procedure Clarified: • Capability • Constraint • Context • Environmental_Property • Environmental_Zone • Measurement • Measurement_Criterion • Zone_Requirement
	Design Rationale	Design Considerations	Related PYRAMID Concept (Resource Management) clarified
	Services	NA	Clarified: • Conditioning_Action_Execution • Environmental_Property_Measurement • Constraint

Component	Section	Sub-Section	Change Detail
Flights	Responsibilities	NA	manage_according_to_structure renamed to maintain_flight_control_structure
	Design Rationale	Assumptions	Revised
	Services	NA	Revised • Capability_Evidence Clarified • Flight_Role_Requirement • Role_Transfer • Flight_Membership • Information
Fluids	Subject Matter Semantics	Exclusions	Revised
		Semantics Diagram	Revised
	Design Rationale	Assumptions	All assumptions deleted
	Services	NA	Revised: • Capability_Evidence
Geography	Subject Matter Semantics	Entities	Revised: • Geographical_Feature
Health Assessment	Design Rationale	Design Considerations	Clarified: • Use of extensions • Exploitation Considerations
		Safety	Revised IDAL changed to DAL B
	Services	NA	Clarified: • Data Model
HMI Dialogue	Services	NA	Revised: • Capability_Evidence Clarified: • Dialogue_Requirement • Dialogue_Dependency
Human Interaction	Design Rationale	Design Considerations	Clarified
Interlocks	Overview	Control Architecture	Control Architecture has changed from Resource to Service
Jettison	Subject Matter Semantics	Exclusions	Revised
		Entities	Revised: • Jettison_Package Clarified: • Jettison_Action • Jettison_Step_Type
	Design Rationale	Assumptions	Revised
		Design Considerations	Revised
		Safety	Clarified
	Services	NA	Renamed and clarified: • Package_Jettison to Jettison_Solution_Dependency Revised: • Constraint • Capability_Evidence Clarified: • Capability

Component	Section	Sub-Section	Change Detail
Location and Orientation	Overview	Standard Pattern of Use	Clarified
		Examples of Use	Clarified
	Responsibilities	NA	Renamed and clarified: • determine_location_and_orientation_quality to determine_parameter_quality • assess_location_and_orientation_capability to assess_parameter_capability • capture_location_and_orientation_requirements to capture_parameter_requirements
	Subject Matter Semantics	Subject Matter Definition	Clarified
		Entities	Added: • Derivative Clarified: • Requirement • Location • Orientation • Capability
	Design Rationale	Design Considerations	Data Driving PYRAMID Concept clarified
	Services	NA	Renamed and clarified: • Location_Orientation_Requirement to Parameter_Requirement Deleted: • Location_Query • Orientation_Query Added: • Query Revised • Capability • Capability_Evidence Clarified: • Navigational_Data_Parameter
Mass and Balance	Responsibilities	NA	Added: • identify_missing_information • assess_mass_and_balance_capability • predict_capability_progression
	Subject Matter Semantics	Entities	Added: • Capability
	Design Rationale	Design Considerations	Note on capability removed
	Services	NA	Added: • Capability • Capability_Evidence Revised: • Mass_and_Balance_Limit

Component	Section	Sub-Section	Change Detail
Mechanical Positioning	Overview	Standard Pattern of Use	Clarified
	Responsibilities	NA	Clarified: • control_position
	Subject Matter Semantics	Subject Matter Definition	Clarified
		Exclusions	Clarified
		Semantics Diagram	Revised
		Entities	Renamed: • Positional_Relationship to Position_Measurement. Clarified: • Physical_Element_Constraint • Effector_Capability • Effector • Requirement • Effector_Constraint • Positional_Relationship
	Design Rationale	Assumptions	Clarified
		Design Considerations	Clarified Exploitation Considerations revised
		Safety	Clarified
	Services	NA	Revised: • Effector_Demand
Network Routes	Subject Matter Semantics	Entities	Next_Hop_Solution renamed to Next_Hop Added: • Traffic Clarified: • Data_Unit
	Design Rationale	Design Considerations	Exploitation consideration clarified
	Services	NA	Added: • Route_Information Revised: • Transmission_Dependency • Capability_Evidence
Networks	Subject Matter Semantics	Exclusions	Clarified
		Semantics Diagram	Revised
		Entities	Removed: • Measurement_Criterion Added: • Performance Clarified: • Connection • Topology
	Design Rationale	Security	Security classification revised to SNEO
	Services	NA	Clarified: • Network_Requirement • Hop_Dependency • Constraint • Network_Capability • Reachability

Component	Section	Sub-Section	Change Detail
Objectives	Responsibilities	NA	Clarified: • capture_objectives • satisfy_dependencies_between_tasks • identify_dependencies
	Subject Matter Semantics	Semantics Diagram	Clarified
		Entities	Clarified: • Flight • Constraint
	Design Rationale	Design Considerations	Clarified: • Use of extensions • Exploitation Considerations
		Security	Clarified
	Services	NA	Added: • Information_Dependency Clarified: • Task_Dependency • Constraint • Capability_Evidence
Operational Rules and Limits	Services	NA	Added: • Query Revised: • Limit
Path Demands	**Removed from the PRA**		
Power	Subject Matter Semantics	Exclusions	Exclusions removed to revise the component scope
		Entities	Power_Delivery_Solution renamed to Power_Solution Clarified: • Pre-condition
	Services	NA	Power_Information Service renamed to State_Information and revised. Added: • Measurement_Information Clarified: • Operational_State_Requirement Revised: • Power_Capability_Evidence
Pointing	Design Rationale	Design Considerations	Exploitation Considerations clarified
Propulsion	Subject Matter Semantics	Semantics Diagram	Revised
		Entities	Clarified: • Measurement
	Services	NA	Added: • Propulsion_Unit_Dependency • Feedback_Information Revised: • State_Requirement • Environmental_Condition_Dependency • Power_Dependency • Capability_Evidence Clarified: • Propulsion_Requirement • Thrust_Requirement • Constraint

Component	Section	Sub-Section	Change Detail
Reference Times	Overview	Standard Pattern of Use	Revised
	Responsibilities	NA	Clarified: • determine_confidence_in_time
	Subject Matter Semantics	Semantics Diagram	Capability moved
		Entities	Clarified: • Capability • Allowable_Reference_Times
	Design Rationale	Assumption	Four assumptions removed
		Safety	IDAL changed to DAL B
	Services	NA	Revised: • Capability_Evidence Renamed and revised: • Reference_Time to Time_Source_Information Clarified: • Capability
Release Aiming	Overview	Examples of Use	Revised
	Services	NA	Removed: • Condition_Information Added: • Environmental_Condition • Store_Condition • Vehicle_Condition
Release Effecting	Subject Matter Semantics	Exclusions	Revised
	Services	NA	New • Store_Sensor_Information Revised • Capability_Evidence Clarified: • Release_Precondition
Routes	Responsibilities	NA	New: • determine_routing_continuity
	Subject Matter Semantics	Subject Matter Definition	Clarified
		Exclusions	Revised
		Semantics Diagram	Revised
		Entities	Clarified: • Supporting_Information • Positioning_Requirement • Routing_Constraint
	Design Rationale	Assumption	Clarified
	Services	NA	Removed: • Routing_Information Added: • Environmental_Information • Vehicle_Information. Revised: • Constraint • Capability_Evidence Clarified: • Routing

Component	Section	Sub-Section	Change Detail
Resource Brokerage	**Removed from PRA**		
Semantic Translation	Design Rationale	Design Considerations	Clarified
		Safety	Clarified
	Services	NA	Added • Capability_Evidence
Sensing	Services	NA	Removed: • Information_Dependency • Sensing_Resource_Evidence • Processing_Capability_Evidence Added: • Sensor_Platform_Information • Environment_Information • Tactical_Information • Capability_Evidence
Sensor Data Interpretation	Overview	Standard Pattern of Use	Clarified
		Examples of Use	Clarified
	Responsibilities	NA	Clarified: • determine_solution_dependencies
	Subject Matter Semantics	Subject Matter Definition	Revised
		Exclusions	Revised
		Entities	New: • Sensor_Data_Provision_Dependency • Metadata Deleted: • Interpreted_Data_Type • Precondition • Activity_Type Revised: • Interpretation_Capability • Measurement_Criterion Clarified • Interpretation_Resource • Data interpretation_Solution • Requirement Renamed • Sensor_Data to Sensor_Data_Product • Data to Data_Product • Activity_Capability to Interpretation_Resource_Capability • Interpreted_Data to Interpreted_Data_Product • Data_Processing_Activity to Data_Interpretation_Dependency • Dynamic_Inputs to Contextual_Information
	Design Rationale	Design Considerations	Revised
	Services	NA	Removed: • Information_Dependency Added: • Environmental_Information • Sensor Platform_Information Revised • Capability_Evidence • Data_Provision_Dependency

Component	Section	Sub-Section	Change Detail
Sensor Products	Services	NA	Removed: • Sensed_Information Added: • Environmental_Information • Sensor_Platform_Information • Sensor_Measurement_Data • Supporting_Information Revised: • Capability_Evidence
Sensors	Services	NA	Revised: • Sensor_Resourcing
Signature	Role	NA	Clarified

Component	Section	Sub-Section	Change Detail
Spectrum	Role	NA	Revised
	Overview	Control Architecture Layer	Now a resource component
		Standard Pattern of Use	Clarified
		Examples of Use	Revised
	Responsibilities	NA	New: • assess_spectrum_capability • identify_missing_information Deleted: • determine_spectrum_in_use • deliver_spectrum_service • determine_permitted_power_level Renamed: • determine_solutions_to_conflicts to determine_allocation_solution (and revised) • identify_solution_remains_feasible to identify_whether_solution_remains_feasible (and clarified)
	Subject Matter Semantics	Subject Matter Definition	Clarified
		Exclusions	Revised
		Entities	New: • Capability • Environmental_Information • Derived_Constraint • Given_Constraint • Interoperability_Criteria Deleted: • Allocation_State Renamed: • Participant to Spectrum_User (and revised) Clarified: • Spectrum_Element_Allocation • Spectrum_Constraint • Requirement
	Design Rationale	Assumption	4th deleted 5th clarified
		Design Considerations	Revised
	Services	NA	New: • Capability • Capability_Evidence Renamed and revised: • Query renamed to Spectrum_Query Updated: • Reservation • Restriction • Use • Constraint
Stores Release	Subject Matter Semantics	Entities	Clarified • Pre-condition • Requirement
	Design Rationale	Design Considerations	Removed reference to KURs
	Services	NA	Authorisation renamed to Store_Release_Permissions and revised Revised: • Capability

Component	Section	Sub-Section	Change Detail
Tactical Objects	Services	NA	Revised • Constraint Clarified: • Capability_Evidence
Target Engagement	Services	NA	New: • Deployable_Asset-Selection Revised: • Requirement • Aiming • Target_Information • Supporting_Information Renamed: • Effect_On_Target to Non-Deployable_Asset_Selection and revised • Deployable_Asset_Use to Asset_Use and revised • Deployable_Asset_Package_Creation to Deployable_Asset_Selection
Tasks	Role	NA	Revised
	Overview	Standard Pattern of Use	Revised
		Examples of Use	Revised
	Responsibilities	NA	New: • capture_contingency_definitions Deleted: • evaluate_predicted_task_solution_quality • identify_preconditions Clarified: • determine_implementation_solution • identify_missing_information • coordinate_solution_enactment • identify_progress_of_solution Revised: • predict_capability_progression • determine_implementation_solution_cost • assess_task_capability Renamed: • satisfy_dependencies_between_actions to satisfy_dependencies_between_derived_needs • capture_task_constraints to capture_system_constraints • evaluate_delivered_task_solution_quality to evaluate_solution_quality
	Subject Matter Semantics	Subject Matter Definition	Revised
		Exclusions	New
		Semantics Diagram	Revised

Component	Section	Sub-Section	Change Detail
		Entities	New: • System_Stimulus • Behavioural_Constraint • Sequence • Relative_Weighting • Information_Need • Contingency_Solution • Priority Deleted: • Type_of_Action • Action_Capability • Pre-Condition • Quality • Task_Capability • Cost Revised: • Composite_Capability • Tactic • Derived_Need • Decision_Information • Tasking • Optimisation_Criterion • Action • Conflict Clarified: • System_Constraint
	Design Rationale	Assumption	Revised
		Design Considerations	Clarified
		Safety	Clarified
	Services	NA	Renamed and revised: • Task to Tasking • Action_Dependency to Solution_Dependency Revised: • Information_Dependency • Capability_Evidence Clarified: • Constraint • Capability
Test	Subject Matter Semantics	Semantics Diagram	Clarified
	Services	NA	Delete: • Authorisation_Dependency Revised: • System_Condition • Capability_Evidence
Threats	Services	NA	Clarified: • Risk_Evidence
Undercarriage	Services	NA	Clarified: • Capability_Evidence
User Roles	Services	NA	Removed: • Contextual_Information Added: • System_Information • User_Situation Revised: • Constraint
Vehicle External Environment	Services	NA	Revised: • Capability_Evidence

Component	Section	Sub-Section	Change Detail
Vehicle Guidance	Overview	Standard Pattern of Use	Revised
		Examples of Use	Examples added and revised
	Responsibilities	NA	New: • ensure_solution_validity • capture_measurement_criteria • ensure_solution_flow • ensure_trajectory_continuity Deleted: • provide_vehicle_trajectory Revised: • determine_planned_vehicle_trajectory
	Subject Matter Semantics	Subject Matter Definition	Clarified
		Exclusions	Revised
		Entities	Entities added: • Validity_Rule Entities removed: • Demand_Source Entities updated: • Trajectory_Requirement • Planned_Trajectory • Observed_Trajectory • Movement_Constraint • Motion_Command
	Design Rationale	Design Considerations	Revised
		Safety	Clarified
	Services	NA	New: • Capability_Evidence • Validity_Check • Performance_Parameter_Change Deleted: • Sensor_Measurement_Evidence • Control_Resource_Evidence Renamed: Observed_Trajectory to Sensor_Measurement Revised: • Trajectory_Demand

Component	Section	Sub-Section	Change Detail
Vehicle Performance	Role	NA	Revised
	Overview	Standard Pattern of Use	Revised
		Examples of Use	New example
	Responsibilities	NA	New: • determine_performance_envelope • capture_performance_demands • capture_vehicle_activity Renamed and revised: • capture_performance_regime renamed with manage_performance_regime Revised: • assess_capability • determine_applicable_values
	Subject Matter Semantics	Subject Matter Definition	Revised
		Exclusions	Revised
		Entities	New: • Vehicle_Activity • Performance_Envelope • Performance_Envelope_Demand Revised: • Performance_Parameter • Performance_Regime Clarified: • Configuration_Query • Parameter_Query
	Design Rationale	Design Considerations	Exploitation consideration revised
	Services	NA	New: • External_Condition • Vehicle_Configuration • Vehicle_Activity • Performance_Envelope • Performance_Envelope_Demand Deleted: • Vehicle_Performance_Information • Required_Performance_Regime Revised: • Capability_Evidence

Component	Section	Sub-Section	Change Detail
Vehicle Stability and Control	Overview	Standard Pattern of Use	Clarified
	Subject Matter Semantics	Entities	New: • Sensor_Measurement • Environmental_State Clarified: • Configuration • Stability_Control_Limit • Control_Effector
	Design Rationale	Assumption	Added
	Services	NA	New: • Environment_Integration Revised: • Constraint • Capability_Evidence Clarified: • Capability
Weather	Design Rationale	Design Considerations	Revised

Table 5: PRA Component Changes

B.4 Glossary Changes

There have been changes throughout the glossary, including the structure and text, as well as changes to the terms defined by the glossary. There have been many terms added, removed, and changed. Acronyms and abbreviations have also been added and removed.

Appendix C: PYRAMID Model Installation Instructions

The PYRAMID model incorporates the modelled content included in both the PYRAMID Technical Standard, Ref. [1], and the accompanying guidance document, Ref. [2]. The PYRAMID model for exploiter's contains the following:

- Component Composition
- Component Composition Use Cases
- Component Set
- Modelled diagrams used in the PYRAMID Concepts
- PYRAMID Interaction Views
- Glossary

The PYRAMID model has been created using version v9.5 of the Windchill Modeler toolset. The PYRAMID model is available in CWF, XMI, and HTML file formats. Some limitations remain with the PYRAMID model in the XMI and HTML formats when compared against the PYRAMID model viewed in the tooling environment in which it was developed. Installation instructions and known limitations of the respective file formats are provided below.

C.1 CWF

The .cwf file can be loaded into a Windchill Modeler model for use. Please note that a version of the toolset compatible with v9.5 will be required to be able to access the PYRAMID model. To ensure correct visibility of model artefacts it is necessary to have the SysML (Full Profile) installed in the model.

Steps:

- The user should create a new model or locate the model into which to load this release of the PYRAMID model – the destination model. Open the destination model in Windchill Modeler.
- Unpack the .cwf file and save to a local network directory of the users choosing.
- From the destination model in Windchill Modeler the user should select the 'Component Wizard' tool from the 'Tools' drop down menu and then select the sub-option to 'Import From Directory'. This action will open the relevant import wizard.
- The user can then step through the import wizard to import the .cwf file into the destination model. By using this wizard, users will be able to select the .cwf file from the directory above and then browse exactly which model elements this contains before importing. Users can step through the wizard selecting the appropriate settings they require (model dependent) to import the PYRAMID model into their own model.
- Finally, users should check the PYRAMID model import by opening the selected model and ensuring the selected model artefacts have been restored. At this point access controls can be applied to the model and permissions to view in a read only or editable state can also be set by the user. The model .cwf file is supplied with all previous permissions removed. These will need to be set locally by the appropriate model administrator.

C.2 XMI

The method for use of the XMI file is toolset dependent; therefore, it is not appropriate to provide guidance in this document on how a user should view or use the PYRAMID model thus created.

C.2.1 Limitations

- No diagrams (including text diagrams) are available in the XMI format as per the definition of the XMI standard itself Ref. [6].
- The PYRAMID model has been developed using both UML and SysML notations and XMI is limited to UML. Model artefacts are created as the “nearest” equivalents when necessary (e.g., Requirements represented as Classes).

C.3 HTML

Steps:

- Unpack the HTML zip file and save to a local network directory of the user’s choosing.
- Launch the HTML file in the browser of choice (refer to limitations below).

C.3.1 Limitations

- The following are the compatible browsers according to the tool vendor:
    - Internet Explorer 8 – 11 + Metro
    - Firefox 6 – 28.0
    - Google Chrome 14.0.035.163 – 33.0.1750.154m
    - Safari for Windows 5.1 – 5.1.7
- If Google Chrome is not used, then an error message relating to local file access will be presented to the user. When you run Google Chrome, you may still get this error message, this exact error message is dependent on the local set up. The steps to enable the HTML file to be viewed in the browser of choice are specific to the local set up of the user. Therefore, it is not appropriate to provide further guidance in this document.
- If information is not present where expected, it may be hidden when viewing the PYRAMID model in HTML. This can be rectified by selecting the properties button in the top right of the HTML window to view the properties.
- There is a “Stubbed Links” package within the package browser. This should be ignored by users and is kept to maintain the presentation of the model.
- The leaf level packages of the model often contain roles that do not provide additional information to the user in the HTML format.